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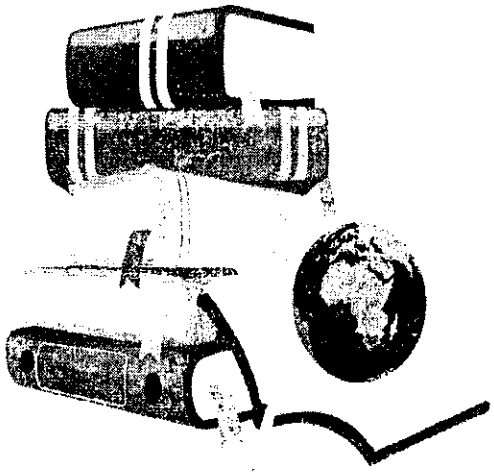

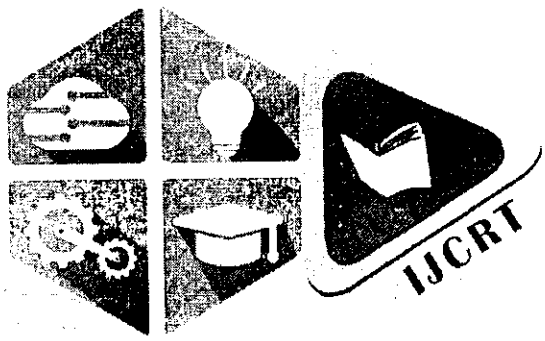

CERTAIN CLASSES OF UNIVALENT ANALYTIC FUNCTIONS WITH SOME FIXED INITIAL COEFFICIENTS

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Abstract: In this paper, we find a subclass of univalent analytic functions by fixing second, third, fourth Taylor coefficients. We investigate coefficient bounds, starlikeness, convexity, growth, distortion theorems, and extreme points for this class.

Index Terms: Univalent functions

Introduction

Let S be the class of all functions of the form $f(z) = z + \sum_{n=2}^{\infty} a_n z^n$

which are analytic and univalent in $U = \{z \in C: |z| < 1\}$.

Let T be the subclass [4] of S of all functions of the form

$$f(z) = z - \sum_{n=2}^{\infty} a_n z^n \,, a_n \geq 0 \qquad (1)$$

for $z \in U$.

A function f(z) ∈ T , is said to be starlike[1] of order α if

$$\text{Re}\left(\frac{zf'(z)}{f(z)}\right) \geq \alpha \,,\ 0 \leq \alpha < 1$$

A function f(z) ∈ T , is said to be convex [1] of order α if

$$\text{Re}\left(1 + \frac{zf''(z)}{f'(z)}\right) \geq \alpha,\ 0 \leq \alpha < 1$$

Silverman [2] proved that if $f(z)$ given by (1) is in T and $a_2 > 0$ then a sufficient condition for $f(z)$ to be in T is given by

$$\sum_{n=3}^{\infty} n(n-1)a_n \leq 2a_2 \qquad (2)$$

Now we introduce a subclass [3] $T(b, d, B_n)$ of T by fixing a_2, a_3 *and* a_4 by imposing a generalized form of the condition (2) as follows:

$$T(b,d,B_n) = \{f \in T: f(z) = z - bz^2 - dz^4 - \sum_{n=5}^{\infty} a_n z^n\} \ \sum_{n=4}^{\infty} B_n a_{n+1} \leq (2b - dB_3) \qquad (3)$$

where $0 \leq b \leq \frac{1}{4}, 0 \leq d \leq \frac{1}{24},\ B_n \geq n(n+1)$.

Section 1

In section 1, we find a coefficient characterization for $T(b, d, B_n)$, a sufficient condition for starlkeness and a condition for functions in this class to be convex of order α.
First we find a necessary condition for functions in $T(b, d, B_n)$ in terms of Taylor coefficients.

Theorem 1: For $0 \leq b \leq \frac{1}{4}, 0 \leq d \leq \frac{1}{24}$, z ∈ U, a function

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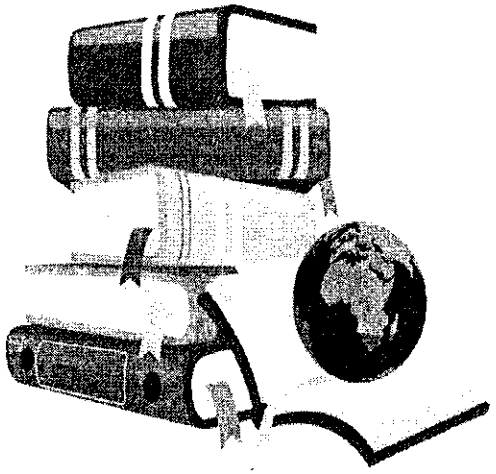

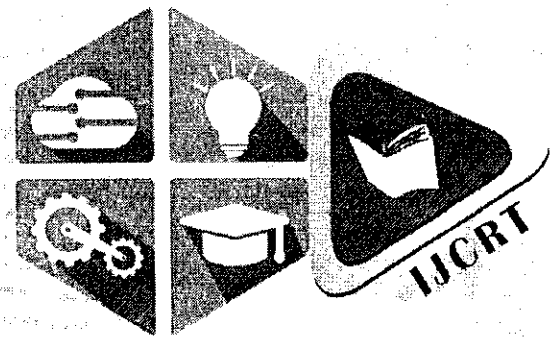

A Class Of Univalent Analytic Functions With Fixed Second And Third Coefficients

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Abstract: In this paper we defined a new class of univalent and analytic functions with fixed second and third Taylor coefficients. Coefficient condition, starlikeness and convexity, extreme points, growth and distortion properties for this class are investigated.

IndexTerms **– Univalent function**

I. INTRODUCTION

Let S be the class of functions of the form $f(z) = z + \sum_{n=2}^{\infty} a_n z^n$ that are analytic and univalent in the unit disk $U = \{z \in \mathbb{C} : |z| < 1\}$. Let T be the subclass of functions of S which are of the form

$$f(z) = z - \sum_{n=2}^{\infty} a_n z^n, \quad a_n \geq 0, \ n = 2, 3, \ldots \tag{1}$$

in U and C be the subclass of functions of T which are convex in U. We have $f \in C$ if and only if $zf' \in T$.

Now we introduce a subclass $T(b, c, B_n) \subseteq T$ by fixing a_2 and a_3, for $0 \leq b \leq \frac{1}{4}$, $0 \leq c \leq \frac{1}{12}$ and $B_n \geq n(n+1)$ for $n \geq 2$,

$$T(b, c, B_n) = \{f(z) \in T: f(z) = z - bz^2 - c\,z^3 - \sum_{n=4}^{\infty} a_n z^n, \ \sum_{n=3}^{\infty} B_n a_{n+1} \leq 2b - c\,B_2\}.$$

Let $C(b, c, B_n)$ be a subclass of functions of $T(b, c, B_n)$ which is convex in U.

This paper consists of two sections. In section 1, we find the coefficient conditions for starlikeness and convexity of the class $T(b, c, B_n)$. In section 2 we find extreme points, growth and distortion properties for the class $T(b, c, B_n)$.

SECTION 1

We need the following definitions from [1].

Definition1: [1] A function $f(z) \in S$ is said to be starlike of order α $(0 \leq \alpha < 1)$ in U, if it satisfies the inequality $Re\left[\frac{z f'(z)}{f(z)}\right] > \alpha$ for $z \in U$. The class of starlike functions of order α is denoted by $S^*(\alpha)$.

Definition 2: [1] A function $f(z) \in S$ is said to be convex of order α $(0 \leq \alpha < 1)$ in U, if it satisfies the inequality $Re\left[1 + \frac{z f''(z)}{f'(z)}\right] > \alpha$ for $z \in U$. The class of convex functions of order α is denoted by $C^*(\alpha)$.

We have $f \in C^*(\alpha)$ if and only if $zf' \in S^*(\alpha)$.

We start with a coefficient characterization for the functions of T to be in the class $T(b, c, B_n)$.

Theorem-1

The function $f(z) = z - bz^2 - cz^3 - \sum_{n=4}^{\infty} a_n z^n$, $z \in U$ is in the class $T(b, c, B_n)$ if and only if $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - 6c$. The result is sharp.

Proof: If $f(z) = z - b\,z^2 - c\,z^3 - \sum_{n=4}^{\infty} a_n z^n$, $z \in U$ belongs to the class $T(b, c, B_n)$,

Then by the definition, we have $\sum_{n=3}^{\infty} B_n a_{n+1} \leq 2b - cB_2$

This gives $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - cB_2$

or $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - c.2.3$

this shows $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - 6c$ (2)

Now, suppose that $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - 6c$

Then $\sum_{n=2}^{\infty} n\, a_n \leq 1$.

Therefore $f(z) \in T$ by [3].

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On Certain Classes of Generalized Rational Functions

V. Srinivas

Abstract: *A normalized function f analytic in the open unit disc around the origin and nonvanishing outside the origin can b expressed in the form z/g(z) where g (z) has Taylor coefficients b_n's. Necessary and sufficient conditions in terms of b_n's are derived f some classes of analytic functions.*

1. Introduction

Let A_1 be the class of functions$f$ analytic in $U = \{z \in C; |z| < 1\}$, and normalized by $f(0)=0, f'(0)=1$ where C is the set of complex numbers. An f in A_1 with $f(z) \neq 0$ in the punctured disc $U/\{0\}$, may be expressed as $f(z) = \psi(g) = z/g(z)$ in U,
where $g(z) = 1 + \sum_{n=1}^{\infty} b_n z^n$ in U.

Mitrinovic [2], Reade et.al [5], Silverman and Silvia [6] and Srinivas [7, 8] studied these coefficients.

Mitrinovic [3] obtained estimates for the radii on univalence of certain generalized rational functions $z/g(z)$. In particular, he found sufficient conditions for functions of the form

(1) $\frac{z}{1+b_1+b_2z^2+....+b_nz^n}$

$b_n \neq 0$, to be univalent in the unit disk U.

A function

(2) $f(z) = z + \sum_{n=2}^{\infty} a_n z^n$

in A_1 is said to be starlike with respect to the origin in U, if it satisfies$Re\frac{zf'(z)}{f(z)} > \alpha$ in U. A function $f(z)$ in A_1 is said to be convex, if $Re\left\{1 + \frac{zf''(z)}{f'(z)}\right\} > 0$ in the unit disc U.

Mac Gregor [1] showed the following.

Theorem A: If $f \in A$ satisfies

$$\left|\frac{f(z)}{z} - 1\right| < 1 (z \in U),$$

then

$$\left|\frac{zf'(z)}{f(z)} - 1\right| < 1 \left(|z| < \frac{1}{2}\right)$$

so that

$$Re\left(\frac{zf'(z)}{f(z)}\right) > 0 \left(|z| < \frac{1}{2}\right)$$

Therefore, $f(z)$ is univalent and starlike for $|z| < \frac{1}{2}$.

Also, Mac Gregor [2] had given the following result.

Theorem B. If $f \in A$ satisfies

then $$|f'(z) - 1| < 1 (z \in U)$$

$$Re\left(1 + \frac{zf''(z)}{f'(z)}\right) > 0 \left(|z| < \frac{1}{2}\right).$$

Therefore $f(z)$ is convex for $|z| < \frac{1}{2}$

The condition domains to Theorem A and Theorem Ba some circular domains whose centre is the point z = 1.

In the research paper Nunokawa et.al [4], some sufficie conditions for starlikeness and convexity under t hypotheses whose condition domains were centered at t origin were obtained as follows.

A result for starlikeness of $f(z)$ is

Theorem C. Let for $f \in A_1$ suppose that

$0.10583 \ldots = \exp\left(-\frac{\pi^2}{4 \log 3}\right) < \left|\frac{zf'(z)}{f(z)}\right| < exp\left(\frac{\pi^2}{4 \log 3}\right)$
$9.44915\ldots (z \in U)$.

Then $f(z)$ is starlike for $|z| < \frac{1}{2}$.

Theorem D. Let for $f \in A_1$ suppose that

$0.472367 \ldots = \exp\left(-\frac{3}{4}\right) < \left|\frac{f(z)}{z}\right| < exp\left(\frac{3}{4}\right)$
$2.1777\ldots (z \in U)$.

Then we have

$$\left|\frac{zf'(z)}{f(z)} - 1\right| < 1 \left(|z| < \frac{1}{2}\right)$$

and$f(z)$ is starlike for $|z| < \frac{1}{2}$.

For convexity of functions $f(z)$, the following result w derived.

Corollary E. Let $f \in A_1$ and suppose that

$0.472367 \ldots = \exp\left(-\frac{3}{4}\right) < |f'(z)| < exp\left(\frac{3}{4}\right)$
$2.1777\ldots (z \in U)$.

Then $f(z)$ is convex for $|z| < \frac{1}{2}$.

A result for convexity of functions $f(z)$ was derived in

Theorem F. Let $f \in A_1$ and suppose that

$0.778801 \ldots = \exp\left(-\frac{1}{4}\right) < \left|\frac{zf'(z)}{f(z)}\right| < exp\left(\frac{1}{4}\right)$
$1.28403\ldots (z \in U)$.
Then $f(z)$ is con

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A Subclass of Meromorphic Functions Defined by Convolution

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ABSTRACT

In this paper we define a subclass $\sum_g(\alpha,\lambda)$ of Meromorphic univalent functions using convolution. We study some geometric properties of this subclass. In the first section of this chapter we discuss a coefficient characterization for a function of Σ_p to be a function of the class $\sum_g(\alpha,\lambda)$. we also discuss growth and distortion properties for functions of the class $\sum_g(\alpha,\lambda)$. In the second section of this chapter we find radii of starlikeness and convexity for the functions of the class $\sum_g(\alpha,\lambda)$. In the third section we find extreme points for the class $\sum_g(\alpha,\lambda)$.

IndexTerms - Meromorphic, Univalent, Convolution.

INTRODUCTION

Let Σ be the class of functions of the form $f(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n z^n$ defined on the punctured unit disk $U^*=\{z\in\mathbb{C}: 0<|z|<1\}$.

Let Σ_p denote the class of meromorphic functions of the form
$f(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n z^n,\ z\in U^*, a_n\geq 0$ for $n=1,2,3,\ldots$
which are defined on the punctured unit disk $U^*=\{z\in\mathbb{C}: 0<|z|<1\}$. (1.1)

If $f(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n z^n$ and $g(z)=\frac{1}{z}+\sum_{n=1}^{\infty}b_n z^n$ are two functions in Σ, the Hadamard product or convolution of f and g is defined by

$$f(z)*g(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n b_n z^n,\ z\in U^*.$$

Mogra et al [2] introduced meromorphic starlike functions of order α and type β, when the coefficients in Laurent series expansion about the origin are all positive and denoted by $\Sigma_P^*(\alpha,\beta)$. And obtained many useful results such as characterization of coefficients, distortion property, radius of convexity, extreme points for the class $\Sigma_P^*(\alpha,\beta)$.

Kavitha et al.[4] defined a new class of meromorphic functions

$$M_p(\alpha,\lambda)=\left\{f\in\Sigma_p: Re\left(\frac{zf'(z)}{(\lambda-1)f(z)+\lambda f'(z)}\right)\geq\alpha\right\} \text{ for } 0\leq\alpha<1,\ 0\leq\lambda<1, z\in U^*$$

and obtained coefficient inequality, growth and distortion bounds, radii of meromorphic starlikeness and meromorphic convexity for this class $M_p(\alpha,\lambda)$.

Definition [2] A function $f(z)\in\Sigma$ is called meromorphically starlike univalent of order α, $0\leq\alpha<1$ if and only if

$$-Re\left\{\frac{zf'(z)}{f(z)}\right\}>\alpha,\ z\in U^*.$$

Definition [2] A function $f(z)\in\Sigma$ is called meromorphically convex univalent of order α for $0\leq\alpha<1$ if and only if

$$-Re\left\{1+\frac{zf''(z)}{f'(z)}\right\}>\alpha,\ z\in U^*$$

A SUBCLASS OF GENERALIZED HARMONIC UNIVALENT FUNCTIONS

By

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ABSTRACT

The main contribution of this article is to define a certain subclass of generalized harmonic univalent rational functions. Complex-valued harmonic functions that are univalent and sense preserving in the unit disk U can be written in the form $f=h+\overline{g}$, where h and g are analytic in U. In the study of harmonic functions geometric properties of certain subclasses were discussed. Conditions of characterization involving bounds on the coefficients lead to various external properties. We further define a new subclass of harmonic rational functions and also find their coefficient characterization and certain geometric properties such as star-likeness, convexity and growth and distortion bounds for the functions of the subclass. Convolution property and extreme points of the subclass has been discussed.

Keywords: Univalent Functions, Harmonic Functions, Rational Functions, Analytic Functions.

INTRODUCTION

Let $U=\{z:|z|<1\}$ denote the open unit disk. A continuous complex valued function $f=u+iv$ defined in a simply connected complex domain U is said to be harmonic in U, if both u and v are real harmonic in U. Every harmonic mapping f in a simply connected domain can be written as $f=h+\overline{g}$, where h and g are analytic.

In particular, we consider the class H of all complex-valued harmonic functions.

$$f=h+\overline{g} \text{ in U normalized by } h(0)=0,\ g(0)=0,\ h'(0)-1=0$$

We call h and g, the analytic and the co-analytic parts of f respectively, and obviously they have the following power series representation for $f=h+\overline{g}$ with,

$$h(z)=z+\sum_{n=2}^{\infty}a_n z^n,\ g(z)=\sum_{n=1}^{\infty}b_n z^n,\ for\ z\in U \qquad (1)$$

A necessary and sufficient condition for f to be locally univalent and sense preserving in U is that,

$|h'(z)|<|g'(z)|$ in U (Clunie & Sheil-Small, 1984). The growth and distortion bounds of harmonic univalent functions are explained.

Harmonic univalent mappings can be considered as close members of conformal mappings. But, in contrast to conformal mappings, harmonic univalent mappings are not at all determined (up to normalizations) by their image domains. It is also noted that a harmonic univalent mapping can be constructed on an interval of the boundary of the open unit disc.

Harmonic mappings have a two series structure consisting of an 'analytic part' which is a power series in the complex variable z, and a 'co-analytic part' which is a power series in the complex conjugate of z. In view of such amazing properties, a study of harmonic univalent mappings is very important. Harmonic univalent mappings have attracted the serious attention of complex analysts only recently after the appearance of a basic paper by Clunie and Sheil-Small (1984).

An analytic function of a harmonic function may not be harmonic. For example, z is harmonic but z^2 is not. But, a product of

ON A CERTAIN SUBCLASS OF MEROMORPHIC FUNCTIONS DEFINED BY SALAGEAN OPERATOR FIXING SOME TAYLOR COEFFICIENTS

By

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ABSTRACT

In the present paper, an interesting subclass of meromorphic univalent functions defined on a punctured unit disk $E=\{z: |z|1>1\}$ has been considered and studied. A sufficient condition for these functions to be univalent and sense preserving in the class has been obtained. Certain geometric properties of the functions of the subclass of meromorphic functions has been discussed, such as coefficient inequality, starlike-ness, convexity, growth and distortion, convex linear combination and extreme points of the functions of the class by fixing some Taylor coefficients.

Keywords: Univalent Functions, Geometric Properties, Coefficient Inequality, Fixed Coefficients.

INTRODUCTION

Geometric function theory is a branch of complex analysis which deals with the geometric properties of the functions such as starlikeness convexity, growth and distortion bounds, extreme points etc. We mainly concentrate on univalent functions and their geometric properties. A complex valued function is said to be analytic in a unit disk $U=\{z: |z|<1\}$ if it is differentiable at each and every point of the domain. An analytic function f (z) is said to be univalent in a unit disk U if it does not take same value for any $z_1, z_2 \in U, z_1 \neq z_2$.

Consider $f(z) = a_0+a_1z+a_2z^2+\ldots$, with $a_n \geq 0$ for $n \geq 0$ be the Taylor's series expansion of any f(z) in U. For our convenience we rewrite the above series as $f(z) = z+\Sigma^{\infty}_{n=2} a_nz^n$ which is said to be a normalized univalent function. The set of all normalized univalent functions is denoted by S.

Definition 1.1. An univalent function f (z) is said to be starlike of order α if $\Re\left(\frac{zf'(z)}{f(z)}\right) \geq 0$ for $0 \leq \alpha < 1$ (Goodman, 1983).

Definition 1.2. An analytic function is said to be convex of order α, if $\Re\left(1+\frac{zf''(z)}{f'(z)}\right) \geq 0$, for $0 \leq \alpha < 1$ (Goodman, 1983).

The growth of an univalent function gives bounds for f(z) and distortion gives bounds of f'(z).

Let Σ be the class of meromorphic functions of the form $f(z)=1/z+\Sigma^{\infty}_{n=1} a_nz^n$ defined in a punctured unit disk $E=\{z\in C:|z|>1\}$ (Clunie, 1959).

Definition 1.3. A function f(z) of the above form is said to be starlike of order α for $0\leq \alpha < 1, z \in E$ if $Re\{-zf'/f\} > \alpha$ (Clunie, 1959).

Definition 1.4. A function f(z) of the above form is said to be convex (Clunie, 1959) of order α for $0\leq \alpha < 1, z \in E$ if $Re\{-(1+zf''/f')\} > \alpha$.

In 1925, Nevanlinna presented a large survey of his theory of meromorphic functions which is regarded as Nevanlinna's main work. Complex Dynamics is a thrust area in modern function theory and two consective Fields Medals in 1990s were

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On Certain Classes of Meromorphic Functions

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ABSTRACT:
A meromorphic function with a simple pole at $z = 0$ and of the form $f(z) = \frac{1}{z} + \sum_{n=0}^{\infty} a_n z^n$ for $z \in D \equiv \{z \in \mathbb{C}: 0 < |z| < 1\}$ with $f(z) \neq 0$ in D can be expressed as $f(z) = \frac{1}{zg(z)}$ where $g(z) = 1 + \sum_{n=1}^{\infty} b_n z^n$ in D. In this paper certain coefficient criteria are derived for some classes of meromorphic functions.

KEYWORDS: Meromorphic function, univalent starlike function.

INTRODUCTION

Let $\tilde{M}$ denote the class of functions which are analytic in $D = D(1)$ where
$D(r) = \{z \in \mathbb{C}: 0 < |z| < r\}$ for $r > 0$,
with a simple pole at the point $z = 0$ and $\mathbb{C}$ being the set of complex numbers. By M, we denote the class of functions $f \in \tilde{M}$ of the form
$f(z) = \frac{1}{z} + \sum_{n=1}^{\infty} a_n z^n \ (z \in D)$ (1)
Also, by τ_η^ε $(\eta \in R, \ \varepsilon \in \{0,1\})$, we denote the class of functions $f \in M$ of the form (1) for which
$\arg(a_n) = \varepsilon\pi - (n+1)\eta \quad (n \in N \equiv \{1,2,3,\ldots\})$.
For $\eta = 0, \ \varepsilon = 0$ we obtain the class τ_0^0 of functions with positive coefficients.
Motivated by Silverman[3], Djiok[1] defined the class
$\tau^\varepsilon \equiv \bigcup_{\eta \in R} \tau_\eta^\varepsilon$.
It is called the class of functions with varying coefficients.
Let $\alpha \in (0,1), \ r \in (0,1)$. A function $f \in M$ is said to be meromorphically starlike of order α in $D(r)$ if

$$\operatorname{Re}\left(\frac{zf'(z)}{f(z)}\right) < -\alpha \quad (z \in D(r)). \quad (2)$$

Djiok[1] introduced the class of all functions in M, which are meromorphically starlike of order α and denoted it by $MS^*(\alpha)$.
We set $MS^* = MS^*(0)$.
For a function $f \in \tau_\eta^0$, the condition (2) is equivalent to

$$\left|\frac{zf'(z)}{f(z)} + 1\right| < 1 - \alpha \quad (z \in D(r)). \quad (3)$$

Let us define a new class $MS^*(A,B)$ which generalizes $S^*(\alpha)$:
A function $f \in M$ is said to be in the class $MS^*(A,B)$ if

$$-\frac{zf'(z)}{f(z)} \prec \frac{1+Az}{1+Bz} (z \in D(r)),$$

where $-1 \leq B < A \leq 1$ and "$\phi \prec \mu$" means that $\phi(D) \subseteq \mu(D)$. We have
$MS^*(1-2\alpha, -1) = MS^*(\alpha)$.

Kulkarni and Joshi[2] studied the class $\sum(\alpha, \beta, \gamma)$ of functions $f \in \Sigma$ satisfying the condition

$$\left|\frac{\frac{zf'(z)}{f(z)} + 1}{2\gamma\left(\frac{zf'(z)}{f(z)} + \alpha\right) - \left(\frac{zf'(z)}{f(z)} + 1\right)}\right| \leq \beta \quad (4)$$

for

$$(z \in D)\left(0 \leq \alpha < 1; \ 0 < \beta \leq 1; \ \frac{1}{2} < \gamma \leq 1\right).$$

Σ is the class of functions in $\tilde{M}$ which are univalent in D.
In this paper we find sufficient conditions in terms of b_n's in Theorems-1, 2 and 3 for some subclasses of $MS^*(\alpha)$, $MS^*(A,B)$ and $\sum(\alpha, \beta, \gamma)$ respectively.

SECTION-1

In this section we find a sufficient condition in Theorem-1 for the subclass of $\tau_\eta^0 \cap MS^*(\alpha)$.

GEOMETRIC PROPERTIES OF ℓ–HYPERGEOMETRIC FUNCTION

V.SRINIVAS[1,*] AND K. V. VIDYASAGAR[2,*]

ABSTRACT. In this paper, we derive sufficient conditions under which ℓ-Hypergeometric functions and ℓ-Hypergeometric exponential functions are close-to-convex with respect to the certain starlike functions and strongly starlikeness.

1. INTRODUCTION

Let $\mathcal{A}(\mathbb{D}_1(0))$ denote the class of analytic functions in the open unit disk $\mathbb{D}_1(0) = \{z \in \mathbb{C} : |z| < 1\}$. Let $\mathcal{C}$ be the class of all functions $f \in \mathcal{A}(\mathbb{D}_1(0))$ which are normalized by $f(0) = 0$ and $f'(0) = 1$ and have the form

$$\begin{aligned} f(z) &= z + a_2 z^2 + a_3 z^3 + \cdots \\ &= z + \sum_{n=2}^{\infty} a_n z^n, \ z \in \mathbb{D}_1(0). \end{aligned} \tag{1.1}$$

Two functions $f, g \in \mathcal{A}(\mathbb{D}_1(0))$ we say that f is subordinated to g in $\mathbb{D}_1(0)$ and express symbolically $f(z) \prec g(z)$. if there exists a function $\omega \in \mathcal{A}(\mathbb{D}_1(0))$ with $|\omega(z)| < |z|$ for all $z \in \mathbb{D}_1(0) \ni g(\omega(z)) = f(z)$ in $\mathbb{D}_1(0)$. Furthermore, if function f is univalent in $\mathbb{D}_1(0)$, then g is subordinate to f provided $g(0) = f(0)$ and $g(\mathbb{D}_1(0)) \subset f(\mathbb{D}_1(0))$. By $\mathcal{S}$ we denote the class of all functions in $\mathcal{C}$ which are univalent in $\mathbb{D}_1(0)$. Let $\mathcal{S}^*(\varepsilon)$, $\mathcal{C}(\varepsilon)$, $\mathcal{K}(\varepsilon)$, $\widetilde{\mathcal{S}}^*(\varepsilon)$ and $\widetilde{\mathcal{C}}(\varepsilon)$ denote the classes of starlike, convex, close-to-convex, strongly starlike and strongly convex functions of order ε, respectively, and are defined as $(z \in \mathbb{D}_1(0), 0 \le \varepsilon < 1)$

$$\mathcal{S}^*(\varepsilon) = \left\{ f \in \mathcal{C} : \mathcal{R}e\left(\frac{zf'(z)}{f(z)}\right) > \varepsilon \right\},$$

$$\mathcal{C}(\varepsilon) = \left\{ f \in \mathcal{C} : \mathcal{R}e\left(\frac{\left(zf'(z)\right)'}{f'(z)}\right) > \varepsilon \right\},$$

$$\mathcal{K}(\varepsilon) = \left\{ f \in \mathcal{C} : \mathcal{R}e\left(\frac{zf'(z)}{\psi(z)}\right) > \varepsilon, \ \psi \in \mathcal{S}^*(0) \equiv \mathcal{S}^* \right\},$$

$$\widetilde{\mathcal{S}}^*(\varepsilon) = \left\{ f \in \mathcal{C} : \left|\arg\left(\frac{zf'(z)}{f(z)}\right)\right| < \frac{\varepsilon\pi}{2} \right\},$$

and

$$\widetilde{\mathcal{C}}(\varepsilon) = \left\{ f \in \mathcal{C} : \left|\arg\left(1 + \frac{zf''(z)}{f'(z)}\right)\right| < \frac{\varepsilon\pi}{2} \right\}.$$

For more details regarding these classes see [5, 7].

2010 *Mathematics Subject Classification.* 30C45, 30C55, 33C20.

Key words and phrases. univalent function; starlike function; strongly starlike function; close-to-convex function; ℓ-Hypergeometric function.

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Semi groups of Linear Operators

V. SRINIVAS and K. Vijay Kumar

Abstract

This paper will serve a basic introduction to groups of semi groups. It will define a group of semi group in the context of a problems which will serve to motivate further (elementary) theoretical and practical development of linear groups of semi groups including the Hille- Yosida . Applications and some problems is discussed.

1 Introduction

Before defining what a semigroup is, one needs to recognize their global importance. Of course their importance cannot be fully realized until we have a clear definition and developed theory. However, in general, semigroups can be used to solve a large class of problems commonly known as evolution equations. These types of equations appear in many disciplines including physics, chemistry, biology, engineering, and economics. They are usually described by an initial value problem (IVP) for a differential equation which can be ordinary or partial. When we view the evolution of a system in the context of semigroups we break it down into transitional steps (i.e. the system evolves from state A to state B, and then from state B to state C). When we recognize that we have a semigroup, instead of studying the IVP directly, we can study it via the semigroup and its applicable theory. The theory of linear semigroups is very well developed [1]. For example, linear semigroup theory actually provides necessary and sufficient conditions to determine the well-posedness of a problem [3]. There is also theory for nonlinear semigroups which this paper will not address. This paper will focus on a special class of linear semigroups called C_0 semigroups which are semigroups of strongly continuous bounded linear operators. The theory of these semigroups will be presented along with some examples which tend to arise in many areas of application.

2 What is a Semigroup?

Let's begin with the most basic notion of a semigroup.

2.1 Definition (Semigroup) -

A semigroup is a set S coupled with a binary operation $*$ ($*$: $S \times S \to S$) which is associative. That is, $\forall\ x, y, z \in S$, $(x*y)*z = x*(y*z)$. Associativity can also be realized as $F(F(x, y), z) = F(x, F(y, z))$ where $F(x, y)$ serves as the mapping from $S \times S$ to S [4].

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Mathematics Teaching through ICT at BRAOU

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ABSTRACT

Learning mathematics in a conventional system of education is hand nut for some and in distance mode of education, it is more than that for many. In the face to face counselling aspect of distance education, a student comes in direct eye-to-eye contact of a teacher. The more the interaction between a student and a teacher, the more the transfer of knowledge from the teacher to the student is. To bring a student into more interaction with a teacher, the use of Information and Communication Technologies (ICT) is a must in many respects like flexibility, economy etc.,. An objective of the ODL is to bring up students in this system on par with those in the regular stream of education. To achieve this objective ICT's help a lot. The queen of sciences, Mathematics has been taught at Dr.B.R. Ambedkar Open University (BRAOU) at under graduate level for about four decades and at post graduate level for about two and half decades. The main medium of course material is the print version. This has entered the third generation of evolution. The supplementary media are the face to face counselling, the video lessons, the radio lessons, the teleconferencing and the radio phone in program. All the above media form a major part of ICT. The present paper deals with the experiences of the authors, who are from the department of Mathematics at BRAOU, in teaching mathematics through the above media. Some ICT's are highly accessible. One of such ICT is the e-learning. The paper also presents some new ideas concerning e-learning of mathematics.

INTRODUCTION

BRAOU started teaching Mathematics at undergraduate level in the year 1983. Since then Mathematics has been offered as an optional subject for B.A., B.Com. and B.Sc. students .12 Mathematics courses of 48 credits are studied for a bachelor's degree. The total content of the courses is supplied through print medium. This course material is supplemented by contact-cum-counseling sessions. For each undergraduate course, counselling in the subject is provided for 24(=24×1) clock hours.

BRAOU started teaching Mathematics at postgraduate level in the year 1993. Program M.Sc. (Mathematics / Applied Mathematics) are offered at postgraduate degree. Each course is provided with course material and supplemented by 24(=90 minutes × 16) clock hours of face to face counseling in the subject.

The Mathematics course material for B.Sc. and M.Sc. is also supplemented by the following audio visual technologies:

(i) (prerecorded) Video lessons

(ii) (prerecorded) Radio lessons

(iii) (prerecorded) Audio lessons

(iv) Live teleconference

(v) Live phone in programs

At BRAOU the first video lesson in Mathematics was prepared in the year 1987, the first radio lesson was made in the year 1986, the first audio lesson was made in the year 1986, the first teleconference was made in the academic year 2000-2001 in the Indian TV channel DD8 and in the academic year 2002-03 in Mana TV, a KU band channel, and the first radio phone in program took place in the year 2004.

In the following sections the authors present their experiences at BRAOU in the preparation of teleconferencing, video lessons and radio phone in program and online teaching. In the first section Practices at our university Dr BRAOU are presented. In the next section ,the authors also present a new idea of e-learning Mathematics at BRAOU. In the final section, some suggestions are made to improve the performance of ICT at BRAOU.

Practices

A visionary Prof. Afzal Mohammad, as the Vice Chancellor of BRAOU started interactive teleconferencing at BRAOU in the year 1999 [1]. Since then the Department of Mathematics at BRAOU has produced more than two dozens of interactive teleconferences, each of one hour duration [2]. These are one way video and two way audio programs.

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Details of publications of the teacher applied for Senior Professor (Promotion) in the Academic Level-15 under CAS of UGC RSP-2016

1. Name of the Teacher: V. SRINIVAS
2. Department: Mathematics
3. Faculty : Science
4. Date of Appt. as Professor: 01-9-2010
5. Date of Completion of: 10 years as Professor 01-9-2020
6. Total No. of Research Publication: (11) during assessment period

List of ten (10) best Research Publications, published in Peer reviewed Journal / UGC listed Journal during assessment period (Professorship):

Sl No	Year of Publications	Tittles	Name of the Journals	Indexing page No.	
				From	To
1.	2018	On certain subclasses of univalent analytic functi	IJCRT	Vol 6, Issue 1, March	
2.	2018	A class of univalent analytic functions with...	IJCRT	Vol 6, Issue 2, April'18	
3.	2019	A subclass of meromorphic functions	IJRAR	Vol 6, Issue 1, Feb 2019	
4.	2021	A subclass of generalized harmonic univalent fun.	IMJM	Vol 10, No. 1, Jan-Jun	
5.	2021	A subclass of mero-morphic functions defd by Salagean	IMJM	Vol 10, No. 2, July-Dec	
6.	2022	Geometric properties of L-Hypergeometric functions	IJARSEM	Vol 10, Issue 8, Aug	
7.	2022	On certain classes of meromorphic functions	IJAEM	Vol. 4, Issue 8, pp 15	

8.	2022	Semi groups of Linear operators	IJRESM	Vol 10, Issue 8, Aug 2022	
9.	2022	On generalized Rational Functions	IJAEM	Single Author	Aug 2022
10.	2022	Mathematics Teaching Through ICT at BRAOU	IJARESM	Vol 10, Issue 8, Aug 2022	
11	2022 Single author	On certain classes of gmc.	IJSR		Aug 202

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2	S. LALITA	Submitted Thesis	in Oct 2019 at Rayalaseema Uni
3	Y. Sita Vani	About to give pretalk at JNTUKakinada	
1	S.LALITA	2013	MPhil
2	T. Rajesh Kumar	2022	MPhil

Signature of the Teacher

A Class Of Univalent Analytic Functions With Fixed Second And Third Coefficients

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[1]Research Scholar, [2]Professor
[1]Department of Mathematics,
[1]Rayalaseema University, Kurnool, India

Abstract: In this paper we defined a new class of univalent and analytic functions with fixed second and third Taylor coefficients. Coefficient condition, starlikeness and convexity, extreme points, growth and distortion properties for this class are investigated.

IndexTerms **– Univalent function**

I. INTRODUCTION

Let S be the class of functions of the form $f(z) = z + \sum_{n=2}^{\infty} a_n z^n$ that are analytic and univalent in the unit disk $U = \{z \in \mathbb{C} : |z| < 1\}$. Let T be the subclass of functions of S which are of the form

$$f(z) = z - \sum_{n=2}^{\infty} a_n z^n, \quad a_n \geq 0, \quad n = 2, 3, \ldots \tag{1}$$

in U and C be the subclass of functions of T which are convex in U. We have $f \in C$ if and only if $zf' \in T$.

Now we introduce a subclass $T(b, c, B_n) \subseteq T$ by fixing a_2 and a_3, for $0 \leq b \leq \frac{1}{4}$, $0 \leq c \leq \frac{1}{12}$ and $B_n \geq n(n+1)$ for $n \geq 2$,

$$T(b, c, B_n) = \{f(z) \in T: f(z) = z - bz^2 - c\,z^3 - \sum_{n=4}^{\infty} a_n z^n, \ \sum_{n=3}^{\infty} B_n a_{n+1} \leq 2b - c\,B_2\}.$$

Let $C(b, c, B_n)$ be a subclass of functions of $T(b, c, B_n)$ which is convex in U.

This paper consists of two sections. In section 1, we find the coefficient conditions for starlikeness and convexity of the class $T(b, c, B_n)$. In section 2 we find extreme points, growth and distortion properties for the class $T(b, c, B_n)$.

SECTION 1

We need the following definitions from [1].

Definition1: [1] A function $f(z) \in S$ is said to be starlike of order α $(0 \leq \alpha < 1)$ in U, if it satisfies the inequality $Re\left[\frac{z f'(z)}{f(z)}\right] > \alpha$ for $z \in U$. The class of starlike functions of order α is denoted by $S^*(\alpha)$.

Definition 2: [1] A function $f(z) \in S$ is said to be convex of order α $(0 \leq \alpha < 1)$ in U, if it satisfies the inequality $Re\left[1 + \frac{z f''(z)}{f'(z)}\right] > \alpha$ for $z \in U$. The class of convex functions of order α is denoted by $C^*(\alpha)$.
We have $f \in C^*(\alpha)$ if and only if $zf' \in S^*(\alpha)$.

We start with a coefficient characterization for the functions of T to be in the class $T(b, c, B_n)$.

Theorem-1
The function $f(z) = z - bz^2 - cz^3 - \sum_{n=4}^{\infty} a_n z^n$, $z \in U$ is in the class $T(b, c, B_n)$ if and only if $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - 6c$. The result is sharp.

Proof: If $f(z) = z - b\,z^2 - c\,z^3 - \sum_{n=4}^{\infty} a_n z^n$, $z \in U$ belongs to the class $T(b, c, B_n)$,
Then by the definition, we have $\sum_{n=3}^{\infty} B_n a_{n+1} \leq 2b - cB_2$
This gives $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - cB_2$
or $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - c.2.3$
this shows $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - 6c$ (2)

Now, suppose that $\sum_{n=3}^{\infty} n(n+1)\, a_{n+1} \leq 2b - 6c$
Then $\sum_{n=2}^{\infty} n\, a_n \leq 1$.
Therefore $f(z) \in T$ by [3].

A Subclass of Meromorphic Functions Defined by Convolution

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[2]Dept. of Mathematics, Dr. B.R.Ambedkar Open University, Hyderabad, Telangana.

ABSTRACT

In this paper we define a subclass $\sum_g(\alpha,\lambda)$ of Meromorphic univalent functions using convolution. We study some geometric properties of this subclass. In the first section of this chapter we discuss a coefficient characterization for a function of Σ_p to be a function of the class $\sum_g(\alpha,\lambda)$. we also discuss growth and distortion properties for functions of the class $\sum_g(\alpha,\lambda)$. In the second section of this chapter we find radii of starlikeness and convexity for the functions of the class $\sum_g(\alpha,\lambda)$. In the third section we find extreme points for the class $\sum_g(\alpha,\lambda)$.

IndexTerms - Meromorphic, Univalent, Convolution.

INTRODUCTION

Let Σ be the class of functions of the form $f(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n z^n$ defined on the punctured unit disk $U^*=\{z\in\mathbb{C}: 0<|z|<1\}$.

Let Σ_p denote the class of meromorphic functions of the form

$$f(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n z^n,\ z\in U^*, a_n\geq 0 \text{ for } n=1,2,3,.... \qquad (1.1)$$

which are defined on the punctured unit disk $U^*=\{z\in\mathbb{C}: 0<|z|<1\}$.

If $f(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n z^n$ and $g(z)=\frac{1}{z}+\sum_{n=1}^{\infty}b_n z^n$ are two functions in Σ, the Hadamard product or convolution of f and g is defined by

$$f(z)*g(z)=\frac{1}{z}+\sum_{n=1}^{\infty}a_n b_n z^n,\ z\in U^*.$$

Mogra et al [2] introduced meromorphic starlike functions of order α and type β, when the coefficients in Laurent series expansion about the origin are all positive and denoted by $\Sigma_p^*(\alpha,\beta)$. And obtained many useful results such as characterization of coefficients, distortion property, radius of convexity, extreme points for the class $\Sigma_p^*(\alpha,\beta)$.

Kavitha et al.[4] defined a new class of meromorphic functions

$$M_p(\alpha,\lambda)=\left\{f\in\Sigma_p: Re\left(\frac{zf'(z)}{(\lambda-1)f(z)+\lambda f'(z)}\right)\geq\alpha\right\} \text{ for } 0\leq\alpha<1,\ 0\leq\lambda<1, z\in U^*$$

and obtained coefficient inequality, growth and distortion bounds, radii of meromorphic starlikeness and meromorphic convexity for this class $M_p(\alpha,\lambda)$.

Definition [2] A function $f(z)\in\Sigma$ is called meromorphically starlike univalent of order α, $0\leq\alpha<1$ if and only if

$$-Re\left\{\frac{zf'(z)}{f(z)}\right\}>\alpha,\ z\in U^*.$$

Definition [2] A function $f(z)\in\Sigma$ is called meromorphically convex univalent of order α for $0\leq\alpha<1$ if and only if

$$-Re\left\{1+\frac{zf''(z)}{f'(z)}\right\}>\alpha,\ z\in U^*$$

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CLASS OF GENERALIZED HARMONIC UNIVALENT FUNCTIONS

By

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ABSTRACT

The main contribution of this article is to define a certain subclass of generalized harmonic univalent rational functions. Complex-valued harmonic functions that are univalent and sense preserving in the unit disk U can be written in the form $f=h+\overline{g}$, where h and g are analytic in U. In the study of harmonic functions geometric properties of certain subclasses were discussed. Conditions of characterization involving bounds on the coefficients lead to various external properties. We further define a new subclass of harmonic rational functions and also find their coefficient characterization and certain geometric properties such as star-likeness, convexity and growth and distortion bounds for the functions of the subclass. Convolution property and extreme points of the subclass has been discussed.

Keywords: Univalent Functions, Harmonic Functions, Rational Functions, Analytic Functions.

INTRODUCTION

Let $U=\{z:|z|<1\}$ denote the open unit disk. A continuous complex valued function $f=u+iv$ defined in a simply connected complex domain U is said to be harmonic in U, if both u and v are real harmonic in U. Every harmonic mapping f in a simply connected domain can be written as $f=h+\overline{g}$, where h and g are analytic.

In particular, we consider the class H of all complex-valued harmonic functions.

$$f=h+\overline{g} \text{ in } U \text{ normalized by } h(0)=0,\ g(0)=0,\ h'(0)-1=0$$

We call h and g, the analytic and the co-analytic parts of f respectively, and obviously they have the following power series representation for $f=h+\overline{g}$ with,

$$h(z)=z+\sum_{n=2}^{\infty}a_n z^n,\ g(z)=\sum_{n=1}^{\infty}b_n z^n,\ for\ z\in U \qquad (1)$$

A necessary and sufficient condition for f to be locally univalent and sense preserving in U is that,

$|h'(z)|>|g'(z)|$ in U (Clunie & Sheil-Small, 1984). The growth and distortion bounds of harmonic univalent functions are explained.

Harmonic univalent mappings can be considered as close members of conformal mappings. But, in contrast to conformal mappings, harmonic univalent mappings are not at all determined (up to normalizations) by their image domains. It is also noted that a harmonic univalent mapping can be constructed on an interval of the boundary of the open unit disc.

Harmonic mappings have a two series structure consisting of an 'analytic part' which is a power series in the complex variable z, and a 'co-analytic part' which is a power series in the complex conjugate of z. In view of such amazing properties, a study of harmonic univalent mappings is very important. Harmonic univalent mappings have attracted the serious attention of complex analysts only recently after the appearance of a basic paper by Clunie and Sheil-Small (1984).

An analytic function of a harmonic function may not be harmonic. For example, z is harmonic but z^2 is not. But, a product of

ON A CERTAIN SUBCLASS OF MEROMORPHIC FUNCTIONS DEFINED BY SALAGEAN OPERATOR FIXING SOME TAYLOR COEFFICIENTS

By

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ABSTRACT

In the present paper, an interesting subclass of meromorphic univalent functions defined on a punctured unit disk $E=\{z:|z|1>1\}$ has been considered and studied. A sufficient condition for these functions to be univalent and sense preserving in the class has been obtained. Certain geometric properties of the functions of the subclass of meromorphic functions has been discussed, such as coefficient inequality, starlike-ness, convexity, growth and distortion, convex linear combination and extreme points of the functions of the class by fixing some Taylor coefficients.

Keywords: Univalent Functions, Geometric Properties, Coefficient Inequality, Fixed Coefficients.

INTRODUCTION

Geometric function theory is a branch of complex analysis which deals with the geometric properties of the functions such as starlikeness convexity, growth and distortion bounds, extreme points etc. We mainly concentrate on univalent functions and their geometric properties. A complex valued function is said to be analytic in a unit disk $U=\{z:|z|<1\}$ if it is differentiable at each and every point of the domain. An analytic function f (z) is said to be univalent in a unit disk U if it does not take same value for any $z_1, z_2 \in U, z_1 \neq z_2$.

Consider $f(z) = a_0+a_1z+a_2z^2+\ldots$, with $a_n \geq 0$ for $n \geq 0$ be the Taylor's series expansion of any f(z) in U. For our convenience we rewrite the above series as $f(z) = z+\Sigma^{\infty}_{n=2} a_nz^n$ which is said to be a normalized univalent function. The set of all normalized univalent functions is denoted by S.

Definition 1.1. An univalent function f (z) is said to be starlike of order α if $\Re\left(\frac{zf'(z)}{f(z)}\right) \geq 0$ for $0 \leq \alpha < 1$ (Goodman, 1983).

Definition 1.2. An analytic function is said to be convex of order α, if $\Re\left(1+\frac{zf''(z)}{f'(z)}\right) \geq 0$, for $0 \leq \alpha < 1$ (Goodman, 1983).

The growth of an univalent function gives bounds for f(z) and distortion gives bounds of f'(z).

Let Σ be the class of meromorphic functions of the form $f(z)=1/z+\Sigma'_{n=1} a_nz^n$ defined in a punctured unit disk $E=\{z\in C:|z|>1\}$ (Clunie, 1959).

Definition 1.3. A function f(z) of the above form is said to be starlike of order α for $0\leq \alpha < 1, z \in E$ if $Re\{-zf'/f\} > \alpha$ (Clunie, 1959).

Definition 1.4. A function f(z) of the above form is said to be convex (Clunie, 1959) of order α for $0\leq \alpha < 1, z \in E$ if $Re\{-(1+zf''/f')\} > \alpha$.

In 1925, Nevanlinna presented a large survey of his theory of meromorphic functions which is regarded as Nevanlinna's main work. Complex Dynamics is a thrust area in modern function theory and two consective Fields Medals in 1990s were

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Authors Name: V. Srinivas1, K. V. Vidyasagar

Paper Title: Geometric Properties Of L–Hypergeometric Function

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